ENVI Tutorial: Georeferencing Images Using Input Geometry

Georeferencing Images Using Input Geometry

Data from many sensors now come with detailed acquisition (platform geometry) information that allows model-based geometric rectification and map registration. This tutorial provides basic information about georeferenced images in ENVI and model-based geometric correction using image input geometry within ENVI. It discusses required data characteristics and covers step-by-step procedures for successful registration. It assumes that you are already familiar with general image-registration and resampling concepts.

Files Used in this Tutorial

ENVI Resource DVD: `Data\cup99hym`

File	Description
`cup99hy_true.img`	True-color composite, Cuprite, NV, 1999 HyMap Data
`cup99hy_true.hdr`	ENVI Header for above
`cup99hy_geo_glt`	Geometry Lookup File
`cup99hy_geo_glt.hdr`	ENVI Header for above
`cup99hy_geo_igm`	Input Geometry File
`cup99hy_geo_igm.hdr`	ENVI Header for above
`copyright.txt`	Description of data copyright

1999 HyMap data of Cuprite, Nevada, used for the tutorial are copyright 1999 Analytical Imaging and Geophysics (AIG) and HyVista Corporation (All Rights Reserved), and may not be redistributed without explicit permission from AIG (info@aigllc.com).

Background

ENVI provides full support for georeferenced images in numerous predefined map projections including UTM and State Plane. In addition, ENVI's user-configurable map projections allow construction of custom map projections utilizing many different projection types, ellipsoids, and datums to suit most map requirements.

ENVI map projection parameters are stored in an ASCII text file `map_proj.txt`. The information in this file is used in the ENVI header files associated with each image and allows simple association of a "magic pixel" location with known map projection coordinates. Selected ENVI functions can then use this information to work with the image in georeferenced data space.

Modern sensors collect ephemeris data along with their image data to allow precision georeferencing to map coordinates. ENVI provides a paradigm for storing sensor geometry information and automatically correcting image data to specified map projections/coordinates. The input geometry (IGM) file contains the x and y map coordinates for a specified map projection for each pixel in the uncorrected input image. The geometry lookup (GLT) file contains the sample and line that each pixel in the output image came from in the input image. If the GLT value is positive, there was an exact pixel match. If the GLT value is negative, there was no exact match and the nearest neighboring pixel is used.

Three ENVI routines available via the ENVI main menu bar are provided to do the georeferencing:

- **Map > Georeference from Input Geometry > Build GLT** builds a GLT file from input geometry information.

- **Map > Georeference from Input Geometry > Georeference from GLT** performs geocorrection utilizing the Geometry Lookup images.

- **Map > Georeference from Input Geometry > Georeference from IGM** performs geocorrection utilizing the input geometry and creates the GLT file.

Users must have the IGM or GLT file as a minimum to conduct this form of geocorrection. Image geometry data files are available for delivery as products from several sensors, including AVIRIS, MASTER, and HyMap. HyMap is a state-of-the-art aircraft-mounted commercial hyperspectral sensor developed by Integrated Spectronics, Sydney, Australia, and operated by HyVista Corporation.

HyMap provides unprecedented spatial, spectral, and radiometric excellence. The system is a whiskbroom scanner utilizing diffraction gratings and four 32-element detector arrays (1 Si, 3 liquid-nitrogen-cooled InSb). Data consists of 126 spectral channels covering the 0.44 - 2.5 mm range with approximately 15nm spectral resolution and 1000:1 SNR over a 512-pixel swath. Spatial resolution is 3-10 m (approximately 8 meters for the Cuprite data used here). Because the instrument uses a gyro-stabilized platform, the initial image geometry (prior to this correction) is quite good and corrections are minor.

While geocorrected images produced using the above methods are visually pleasing and map-correct, they do have several practical drawbacks. First, they have null values around their edges that must be masked in processing. Second, they are often inflated in size by replicated pixels as indicated in the GLT files. These two disadvantages lead to our suggestion to acquire and process the hyperspectral imagery in its raw spatial format, then apply the geocorrection to the derived final products. It is not recommend that you geocorrect the entire reflectance data cube.
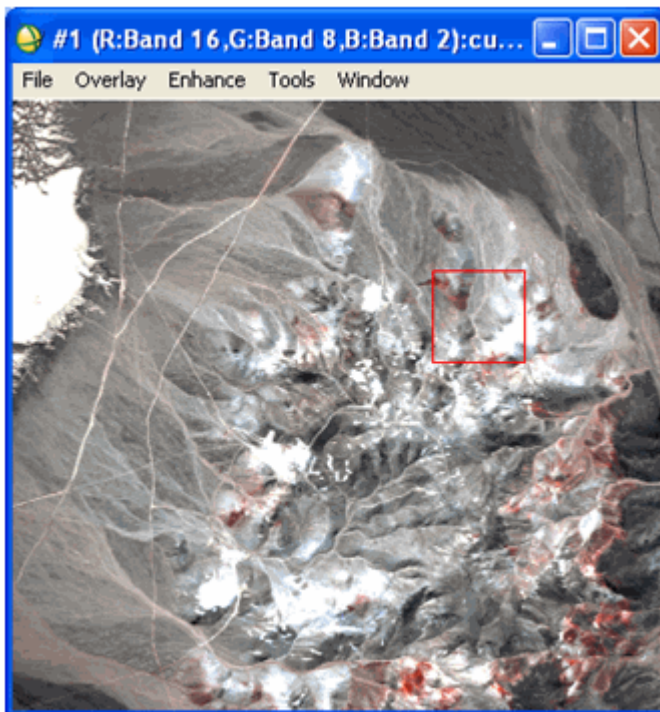
The following sections provide examples of the model-based geocorrection built into ENVI.

Opening and Exploring Uncorrected HyMap Hyperspectral Data

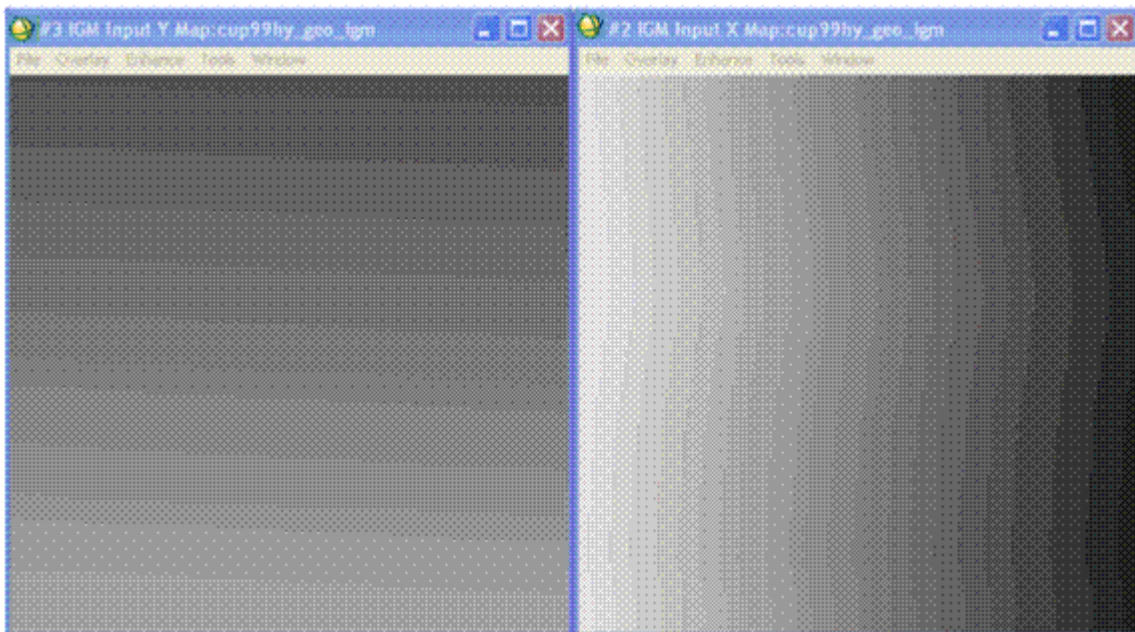This portion of the tutorial will familiarize you with uncorrected image geometry and characteristics.

Before attempting to start the program, ensure that ENVI is properly installed as described in the *Installation and Licensing Guide* that shipped with your software.

1. From the ENVI main menu bar, select **File > Open Image File**.

2. Navigate to the `Data\cup99hym` directory, select the file `cup99hy_true.img` from the list, and click **Open**. The Available Bands List appears on your screen and the image is loaded into the display. This is a true-color image extracted from the HyMap reflectance data.

3. Examine the characteristics of the uncorrected HyMap data by displaying the Cursor Location/Value dialog. Double-click in the Image window. A dialog box displays the location of the cursor in the Image, Scroll, or Zoom windows. The dialog also displays the screen value and the actual data value of the pixel underneath the crosshair cursor.

4. Move the cursor throughout the image. Examine the pixel locations and data values, and geometric relations between pixels (rotation, road curvature, etc.).

5. From the Cursor Location/Value dialog menu bar, select **File > Cancel** to dismiss the dialog.

Opening and Exploring HyMap Input Geometry Data (IGM)

1. From the ENVI main menu bar, select **File > Open Image File**.

2. Navigate to the `Data\cup99hym` directory, select the file `cup99hy_geo_igm` file from the list, and click **Open**. The Available Bands List appears.

3. From the Available Bands List dialog, select the **IGM Input X Map** file from the list. The band you have chosen will be displayed in the Selected Band field.

4. Click **Display #1** and select **New Display**.

5. Click the **Load Band** button to load the image into the new display.

6. Examine the characteristics of the uncorrected HyMap data using the **Cursor Location/Value** feature. Move the cursor throughout the image, and examine the pixel locations and data values (map coordinates).

7. Load the **IGM Input Y Map** band into a new display and explore the image using the Cursor Location/Value feature.
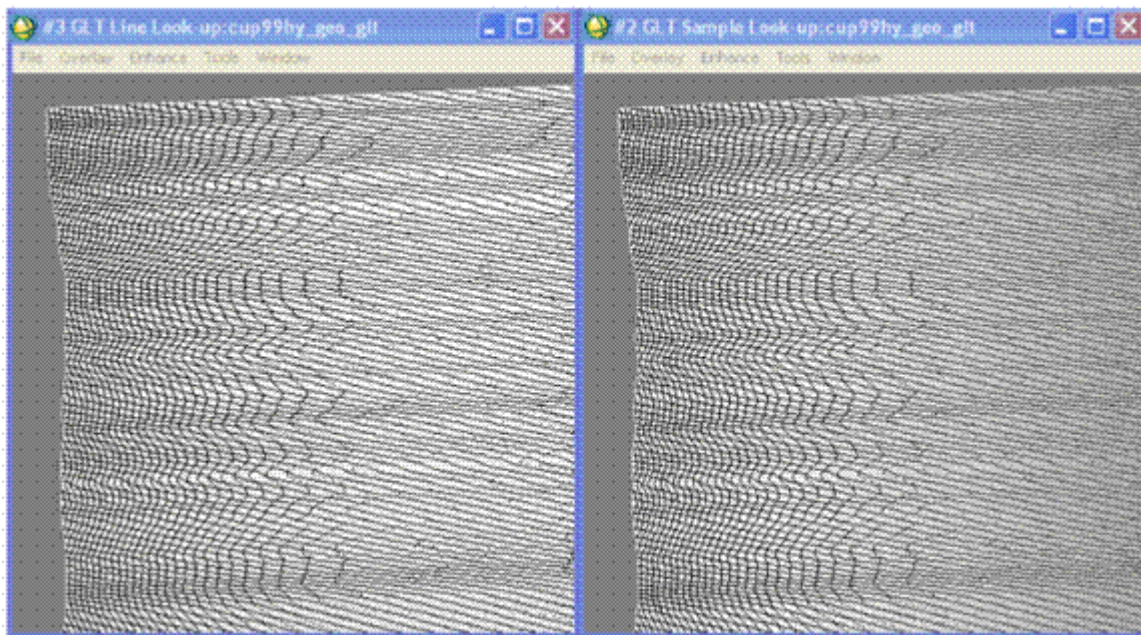
Geocorrecting an Image Using an IGM File

1. From the ENVI main menu bar, select **Map > Georeference from Input Geometry > Georeference from IGM**. The Input Data File dialog appears.

2. Click the **Open** drop-down button and select **New File**.

3. Select the `cup99hy.eff` file and click **Open** to return to the Input Data File dialog.

4. Select the `cup99hy.eff` file and click the **Spectral Subset** button. The File Spectral Subset dialog appears.

5. Select **Band 109** and click **OK** to return to the Input Data File dialog.

6. From the Input Data File dialog, click **OK**. The Input X Geometry Band dialog appears.

7. Select the **IGM Input X Map** band and click **OK**. The Input Y Geometry Band dialog appears.

8. Select the **IGM Input Y Map** band and click **OK**. The Geometry Projection Information dialog appears.

9. For both the input an output projections, select **UTM**, the **North America 1927** datum, **Zone 13**, and click **OK**. This produces an image with the same map projection as the input geometry. The Build Geometry Lookup File Parameters dialog appears.

10. Type or choose an output filename for the GLT file.

11. In the **Georeference Background Value** field, type **-9999**.

12. Type or choose an output filename for the georeferenced image and click **OK**.

Displaying and Evaluating Correction Results

1. From the Available Bands List, load the **Georef** band into a new display.

2. Examine the characteristics of the data using the Cursor Location/Value feature. Move the cursor throughout the image, and examine the image geometry, pixel locations, map coordinates, and data values.

3. Close the IGM displays when finished examining results.

Examining Geometry Lookup (GLT) Files

1. From the ENVI main menu bar, select **File > Open Image File**.

2. Navigate to the `Data\cup99hym` directory, select the file `cup99hy_geo_glt` file from the list, and click **Open**. The Available Bands List appears.

3. Load the **GLT Sample Look-up** band into a new display group.

4. Examine the characteristics of the data using the Cursor Location/Value feature. Move the cursor throughout the image, and examine the pixel locations and data values (input pixel locations). Pay particular attention to the negative values, which indicate use of nearest neighbor pixels.

5. Load the **GLT Line Look-up** band into a new display group, and explore the image using the Cursor Location/Value feature.

Geocorrecting an Image Using a GLT File

1. From the ENVI main menu bar, select **Map > Georeference from Input Geometry > Georeference from GLT**. The Input Geometry Lookup File dialog appears.

2. Select the `cup99hy_geo_glt` file and click **OK**. The Input Data File dialog appears.

3. Select the `cup99hy.eff` file and click the **Spectral Subset** button. The File Spectral Subset dialog appears.

4. Select **Band 109** and click **OK** to return to the Input Data File dialog.

5. From the Input Data File dialog, click **OK**. The Georeference from GLT Parameters dialog appears.

6. In the **Background Value** field, type **-9999**.

7. Type or choose an output filename for the georeferenced image, then click **OK**.

Displaying and Evaluating Correction Results

1. From the Available Bands List, load the **Georef** band into a new display group.

2. Examine the characteristics of the data using the Cursor Location/Value feature. Move the cursor throughout the image, and examine the image geometry, pixel locations, map coordinates, and data values.

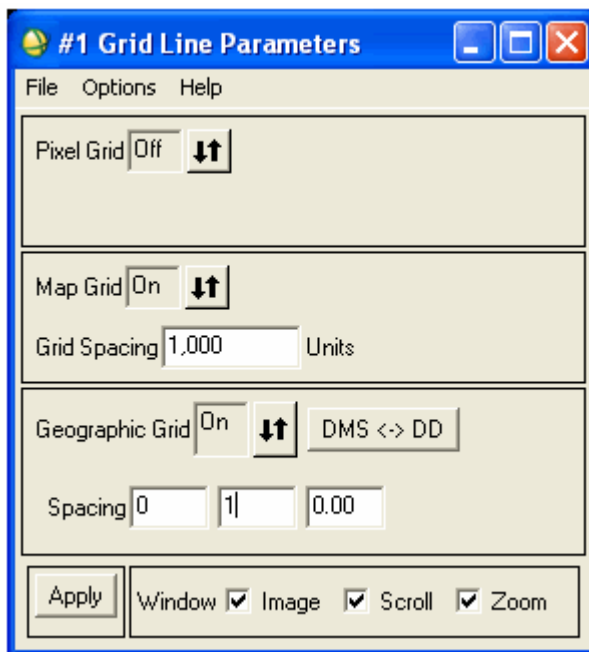3. Close the GLT displays when finished examining results.

Using Build GLT with a Map Projection

1. From the ENVI main menu bar, select **Map > Georeference from Input Geometry > Build GLT**. The Input X Geometry Band dialog appears.

2. Select the **IGM Input X Map** file and click **OK**. The Input Y Geometry Band dialog appears.

3. Select the **IGM Input Y Map** file and click **OK**. The Geometry Projection Information dialog appears.

4. At the bottom of the Geometry Projection Information dialog, select **State Plane (NAD 27)** as the **Output Projection**.

5. Click the **Set Zone** button, select **Nevada West (2703)** as the output zone, and click **OK**.

6. Click **OK** in the Geometry Projection Information dialog. The Build Geometry Lookup File Parameters dialog appears.

7. Type or choose an output filename for the GLT file and click **OK** to create the GLT.

8. Using the steps listed under "Geocorrecting an Image Using a GLT File", geocorrect **Band 109** of the `cup99hy.eff` data and compare the resulting image to the UTM-corrected image.

9. Close all display groups by selecting **Window > Close All Display Windows** from the ENVI main menu bar.

Overlaying Map Grids

1. In the Available Bands List dialog, load one of the georeferenced images produced above.

2. From the Display group menu bar, select **Overlay > Grid Lines**. The Grid Line Parameters dialog appears. A virtual border will be added to the image to allow display of map grid labels exterior to the image.

3. Change the **Map Grid Spacing** to **1000** and the **Geographic Grid Spacing** to **1** minute, and click **Apply**.

4. Examine the characteristics of the data using the Cursor Location/Value feature. Compare the grids to the pixel coordinates.

Saving the Image

ENVI gives you several options for saving and outputting your image maps. You can save your work in ENVI's image file format, or in several popular graphics formats (including Postscript) for printing or importing into other software packages.

1. From the Display group menu bar, select **File > Save Image As > Image File**. The Output Display to Image File dialog appears.

2. Ensure the **Output File Type** drop-down menu reads **ENVI**.

3. Select the **Memory** radio button and click **OK** to output the image.

4. Load the RGB image into another display and examine the results of the grid annotation as a raster image.

Direct Printing

ENVI also allows direct printing to devices supported by your operating system. Select **File > Print** and follow your standard printing procedures. For example, in Microsoft Windows, you would select the printer name from the pulldown menu, change the properties as desired, and click on OK to print the image. Once you have selected all of the parameters and clicked OK, a dialog appears to allow you to set additional basic ENVI printing parameters similar to those used for postscript output. Set these as desired and click OK to begin printing.

Ending the ENVI Session

You can quit your ENVI session by selecting **File > Exit** from the ENVI main menu bar.